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Theme: Project engineering, BIM technologies, experiences and applications

La sostenibilidad del proceso inversionista, en el proceso de explotación, soportado por la tecnología BIM

The sustainability of the investment process during its exploitation, supported by BIM technology

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Abstract

The investment process needs a dynamic and continuous management system from beginning to end, governed by an updated regulatory framework and by Building Information Modeling technology, which provides discipline, organization, integration and computer support, in an integrated management system. , which guarantees the exploitation process, in which the established results are materialized, in the feasibility study of the basic engineering, within the established period of time, within the framework of the budget and with the quality required, by the client and the concerned parties. The objective of the work is to develop a full-cycle investment management process, from beginning to end, focused on the exploitation of the investment, as it is the key process in which the economic and financial management of the investment is achieved. from an improvement of the planning and control of the investment project in its life cycle and an effective management system, in the investment exploitation process, in order to guarantee the expected economic and financial management benefits in the feasibility study of the basic engineering process, supported by BIM technology and the contribution provided by Information and Communication Technologies. In the content of the topic, the planning and control processes are shown, as a basis for the management of the process, the development of the contents in the stages of the exploitation process, through the control of its characteristic curve.

Keywords: *sustainability, management, investments, BIM, exploitation,*

Introduction

The development of the management of the investment process is a necessity of social development, in order to guarantee its ever-increasing demand, due to its marked influence, in the field of economic and financial management of the branches of the economy. The use of updated technologies such as Building Information Modeling, (hereinafter BIM) and the achieved development of the Integrated Project Management, (hereinafter DIP) allow an integrated management process, with the support of information technology, the Science, Technology and Innovation, develop a management system for the investment process, focused on the success of the exploitation management, in which the economic and financial management of the investment materializes

The development of project management systems, the DIP and investment processes have lacked an effective management process of the exploitation process, in which the result of the economic and financial management of the investment is achieved, as planned in the feasibility study, with a system to control changes and the expected sustainability of the cash flow, until reaching the plateau of the characteristic curve of the exploitation. On occasions, investments have not reached their investment recovery period, introduce unforeseen changes that require financing, which alter the behavior of cash flow in the upward curve in the validation of the feasibility study, which impede efficiency planned economic and financial management of the investment.

The development of the topic aims to develop a full-cycle investment management process, from beginning to end, focused on the exploitation of the investment, as it is the key process in which the economic and financial management of investment, based on an improvement in the planning and control of the investment project in its life cycle and an effective management system, in the investment exploitation process, in order to guarantee the benefits of economic management foreseen in the feasibility study of the basic engineering process, supported by BIM technology and the contribution provided by Information and Communication Technologies.

BIM technology is the integrated, strategic, unique, collaborative and multidimensional information system for the management of construction projects, in a 3D virtual model, during the investment life cycle, where the project is prepared before its execution, in a collaborative process of continuous integration and constructability, which allows raising the quality of the preparation, to guarantee effective and sustainable constructions, from pre-investment to demolition. It is the methodology that allows the representation of graphic and written documents, with physical and

functional characteristics, developed for comprehensive investment projects, by mature organizations, with significant computer support and a protocol that regulates its operation and orders the investment process.

The protocol is the governing document of the organization for the development of BIM technology, with its impact on the exploitation process, where the expected benefits are obtained from its regulatory framework, given by the ISO 9001, 10006, 19650 and 21500, which provide valuable information in order to facilitate the work of the investment process team.

The ISO 21500 standard was developed since 2008 with the purpose of achieving a guide for DIP. The same part of the fundamental effort of three nations: the United States, the United Kingdom and Germany, through three highly recognized associations such as the Project Management Institute (PMI, 2013); Projects in Controlled Enviroments (PRINCE2, 2019) and The International Project Management Association (IPMA, 2012). They propose the development in five phases, similar to the PMBOK, with its cost system.

The methodology of the investment system supported by the BIM, is developed in three main processes: Before, During and After, with their well-defined contents as established in Decree 327 and in correspondence with the pre-investment, execution and closing phases of the project. The PMBOK of the Project Management Institute defines the process in the following five stages: Initiation, Planning, Execution, Control and Closing.

Materials and Methods

Taking the theoretical framework as a reference, the content is proposed as the life cycle of the investment process, the one collected in figure No 1, according to the provisions of the methodologies that govern BIM, DIP, project management, the chain of values and its cost system, in four key processes, since these are the ones that generate values, they have a schedule, budget and financing, where it generates the financial economic management and its indicators, by the investor, the designer and the builder, basic engineering, detailed engineering, construction and closure, as it is in these processes where values, partial and total results are generated, as deliverables measurable in time, cost and quality, which respond to a contract, in an integrated process of direction.

The basic engineering and the closing is developed by the project team with the investor, the detailed engineering by the designer's team, and the construction by the executor, with differentiated schedules and contracts. The planning and control processes are transversal to the life cycle of the project and generate the management of the investment process.

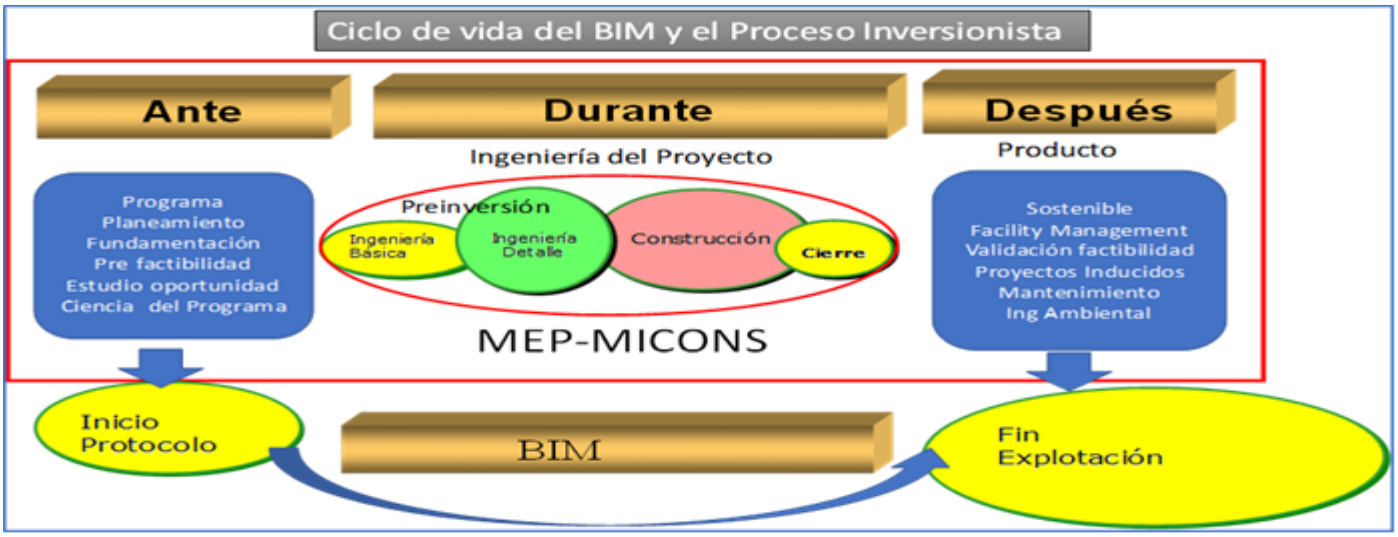


Figure No 1. Project life cycle in BIM

The investment life cycle, as shown in figure No. 1, has a before, during the life cycle of the project and an after, where the exploitation management is developed, in order to guarantee the benefits committed in the feasibility study of basic engineering.

Before

It is the process where the organization's investment program is designed, based on identifying social, economic, financial and political needs, with a vision of the future state of investments, based on the development of the program's science, the Technologies and Innovation, with the study of the historical behavior of the investments of the organization, the diagnosis in the current conditions, to project the future, in an analysis of the trends of the variables and indicators, which characterize the development of the investment process.

It is the process where the planning of the organization's investment program is developed, based on a vision-oriented strategy, based on the strengths of the organization, its knowledge assets and its curriculum, to achieve results, through opportunity studies, market, competencies, risks, stakeholders and pre-feasibility studies, which allow the design of a set of investments that are part of the program, ordered according to priorities.

Intelligent and mature organizations develop their sustainable and sustainable investment processes, based on an investment execution strategy based on priorities, based on the weighting of variables and indicators, with the objective of optimizing the available financing resources, according to the Needs that solve the investments and pay

their benefits to the program, according to the results of the financial economic management of the exploitation of the investments, which guarantees the sustainability of the organization.

The investment program design responds to a comprehensive analysis of the organization's problem tree, the problem bank and the solution tree that generates the possible investments to be developed, depending on the vision of the program. Investments are identified by indicators and variables weighted and ordered in a matrix, they allow, with the advice of a group of experts, to obtain a strategy for the execution of investments, depending on their priorities and the availability of financing.

The sustainability of the organization in the social, political and economic framework is a function of guaranteeing the execution strategy of the program's investments, in a shared resource fund, avoiding improvisations in new investments and developing change management, within the framework of guaranteeing the cash flow of the characteristic curve of the exploitation of the investment, where part of the financing sources of the investments defined in the program's execution strategy is guaranteed.

The execution of the program according to the strategy developed based on the priorities provides a solid base for the development of basic engineering, within the framework of the investment project.

Basic engineering

The life cycle of the investment process has its beginning in Basic Engineering, where the client's needs, conceptual ideas, negotiation, blueprints, risks, permits and cash flow of the feasibility study are specified, in order to elaborate the budget, the financing to proceed with the signing of the investment project contract, committed to the results of the financial economic management, foreseen in the investment exploitation process.

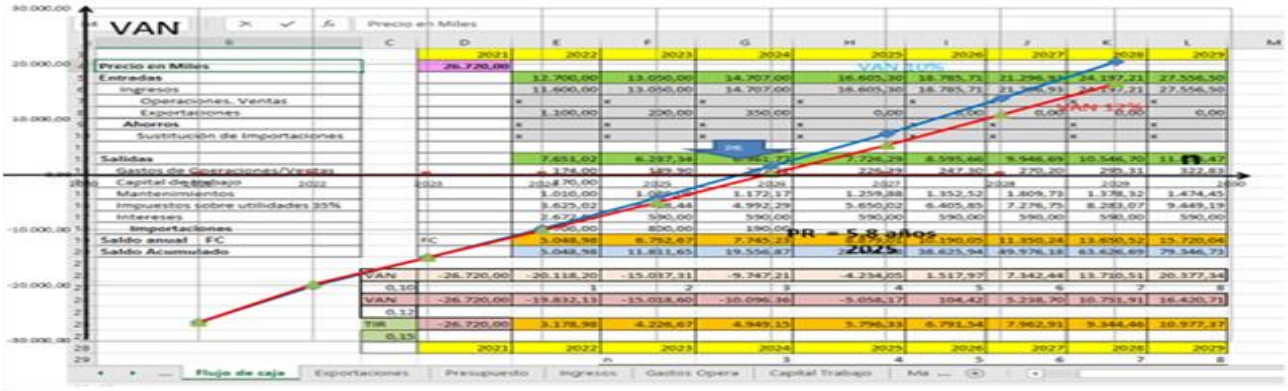


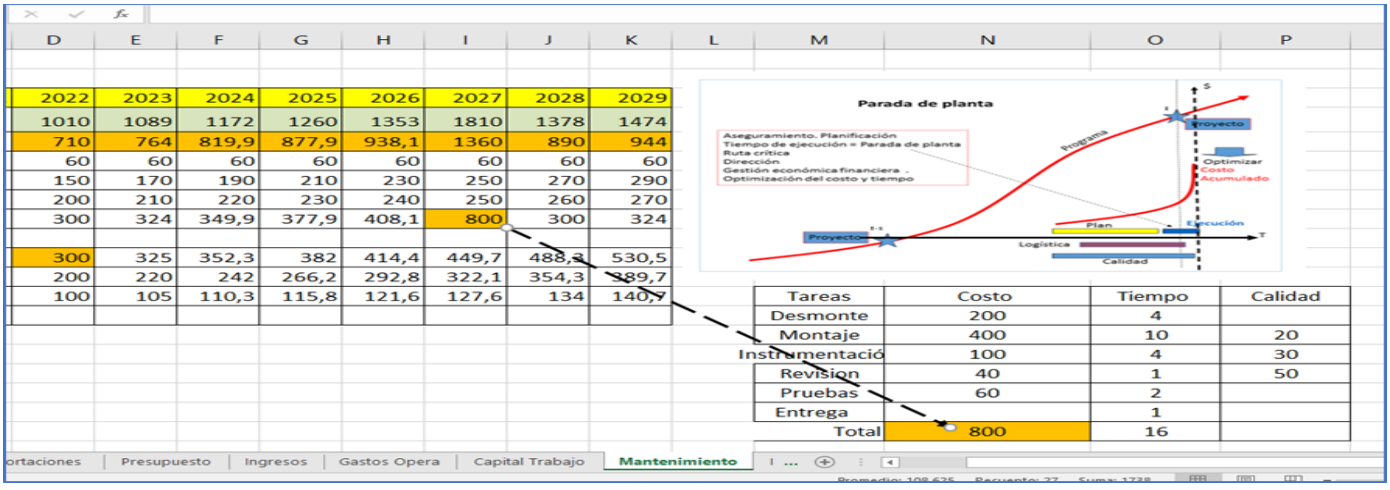
Figure No 2. Cash flow of the feasibility study in Basic Engineering

The cash flow of the feasibility study is shown in figure No 2, making use of the Excel book, which provides the cash flow sheet and the following sheets of the book, which show the detail with the distribution items of costs, such as budget and maintenance among others.

The data of the inputs and outputs with their items, show the values of the planned costs for years until 2030, with the cash flow that allows amortizing the initial investment Year, provided that: maintenance expenses are kept within the planned range for years and the cash flow values are respected for the calculation of the NPV and the IRR, in order to guarantee its upward rhythm shown in the characteristic curve of the investment and to guarantee the investment execution strategy, based on the priorities of planned investments in the program. The cash flow guarantees the upward flow of the NPV and the IRR over time and allows the economic and financial management of the investment to be measured, in the process of exploiting the investment.

Figure No 2 shows an initial project value Ao = $ 26,720 in thousands, determined in 2021, which must be cushioned by the difference between inputs and outputs per year, until the payback period (PR). The inputs and outputs are shown with their items depending on the type of project to be evaluated. These items are detailed in the sheets of the Excel workbook, to easily assess the detail and composition of its components. The example shows the Cash Flow sheet, with its table and on the right the sheet of income, expenses and the rest of the items. The representation of the graphs is shown on the left. The Excel book for the exploitation period can be studied in the supplementary materials.

The entries have as items all the forms that enter values for years. The outputs likewise represent the items that generate expenses. The annual balance of cash flow is the difference between the inflows and the outflows that in the first year are supposed to be positive to amortize the initial investment –Ao.



2022	2023	2024	2025	2026	2027	2028	2029
1010	1089	1172	1260	1353	1810	1378	1474
710	764	819,9	877,9	938,1	1360	890	944
60	60	60	60	60	60	60	60
150	170	190	210	230	250	270	290
200	210	220	230	240	250	260	270
300	324	349,9	377,9	408,1	800	300	324
300	325	352,3	382	414,4	449,7	488,3	530,5
200	220	242	266,2	292,8	322,1	354,3	389,7
100	105	110,3	115,8	121,6	127,6	134	140,7

Figure No 3. Maintenance planning in cash flow

Figure No 3 shows the planning of maintenance costs, highlighting the detail of a boiler plant shutdown, without affecting the cash flow that feeds the NPV and IRR. The approval of the feasibility study allows the preparation of the investment project budget and its contract to proceed with the detailed engineering process.

Detail engineering

The detailed engineering aims to develop the project documentation through the 3D design of the approved preliminary draft in basic engineering, within the framework of the approved directive figures. It has a budget for the design, which is planned and executed at this stage and another budget for the construction that is planned in the detailed engineering and is executed in the next life cycle of the construction. The plans and 3D representations are defined, with the use of computer support such as Revit, Civil 3D, Presto, Preswin or Siecons, Project, Open Project, Gespro, Primavera, Naviswork and Syncho pro, with their specialized complements, elaborated by the designer and his team.

It has the technical means and the necessary knowledge to develop the Duration 4D and Cost 5D dimensions. It develops the 6D preparation of the construction process, with the resources of the builder and the active participation of the investor.

Building process

The construction engineering process is developed from the economic and financial planning of the execution, with the resources of the constructor, developed in the 6D of the preparation in the detailed engineering, with the initial adjustments, appropriate to the environmental conditions. The control by cuts is developed from the baseline and the lines of progress are planned, for the development of the control by the method of the three cuts and the method of the earned value with its indicators, with the aim of developing economic management financial project in the cuts, to execute decision-making, in an integrated management system, which provides the necessary information for the closing of the investment project

The investment project closing process

In the basic engineering process, the directive documentation of the investment project is defined and it is where the document management is developed, the feasibility study is updated, the information system is updated and its validation is prepared in the investment exploitation process.

The investment exploitation process is where the results of the planned economic and financial management materialize in the basic engineering, updated at the closing of the project, with the aim of proceeding to its validation in the exploitation process, through a efficient management of the investor, in the monitoring and control of the roadmap provided by the characteristic curve of the investment in the exploitation process, in order to achieve the closing of the investment before the plateau, with the achievement of benefits economic, financial, environmental and social, planned in the investment program.

The exploitation process has the following objectives:

Objectives:

1. Validate the feasibility study in its life cycle.
2. Develop the management of operations, within the framework of the integrated management system of the exploitation.
3. Develop the processes of Facility Management and maintenance.
4. Guarantee the efficiency and sustainability of the investment until the closing of the investment, before the plateau.
5. Apply the new information and communication technologies.
6. Ensure the reuse of resources and the circular economy.
7. The observance of the protection of the environment and in particular the impact of the exploitation process in nearby communities.

The exploitation process can be very diverse, depending on the type of investment, from industrial construction projects, to agriculture or transportation, with their social, economic, political and environmental impacts, in which the exploitation system has unique characteristics that identify and differentiate them.

Results and discussion

In order to develop the contents of the exploitation process, taking into account the broad spectrum of investments, a set of general input, processing and output actions are proposed, which are expressed below:

Entry

1. Preparation of the exploitation at the closing of the project.
2. Certificate of usable for exploitation. Information system.

Prosecution

1. Life cycle of the farm.
2. Validation of the feasibility study. Investment sustainability.

Direction system

Stage 1. Development of the project life cycle and its closure.

1. Updating of the feasibility study and preparation of the exploitation.

Stage 2. Recovery period. Detained. Services. Conservation.

1. Property. Fixed assets value. Operations management.

2. Facility Management. Maintenance Strategy. Change management.

Stage 3. Guarantee the efficiency and sustainability of the investment up to the plateau. Continuous improvement.

Improvement

1. Innovation.

2. Preventive maintenance. Corrective Predictive. As built

3. Training. Maturity. Inspections Logistics. Internal controls.

4. Contracting system. Continuity.

Stage 4. Evaluation of the plateau.

Stage 5. Develop the closure of the exploitation before the plateau.

1. Guarantee the reuse of resources and the circular economy.

Departure

Closing of the investment. Investment record. Good practices.

Information system.

Processing the exploitation

It is developed according to the content of its objectives in five main stages that show the characteristic curve of the investment exploitation process, with the aim of evaluating the efficiency of the investment and its sustainability, from the recovery period with the management of operations, the application of Facility Management and the maintenance policy, with the support of ICT.

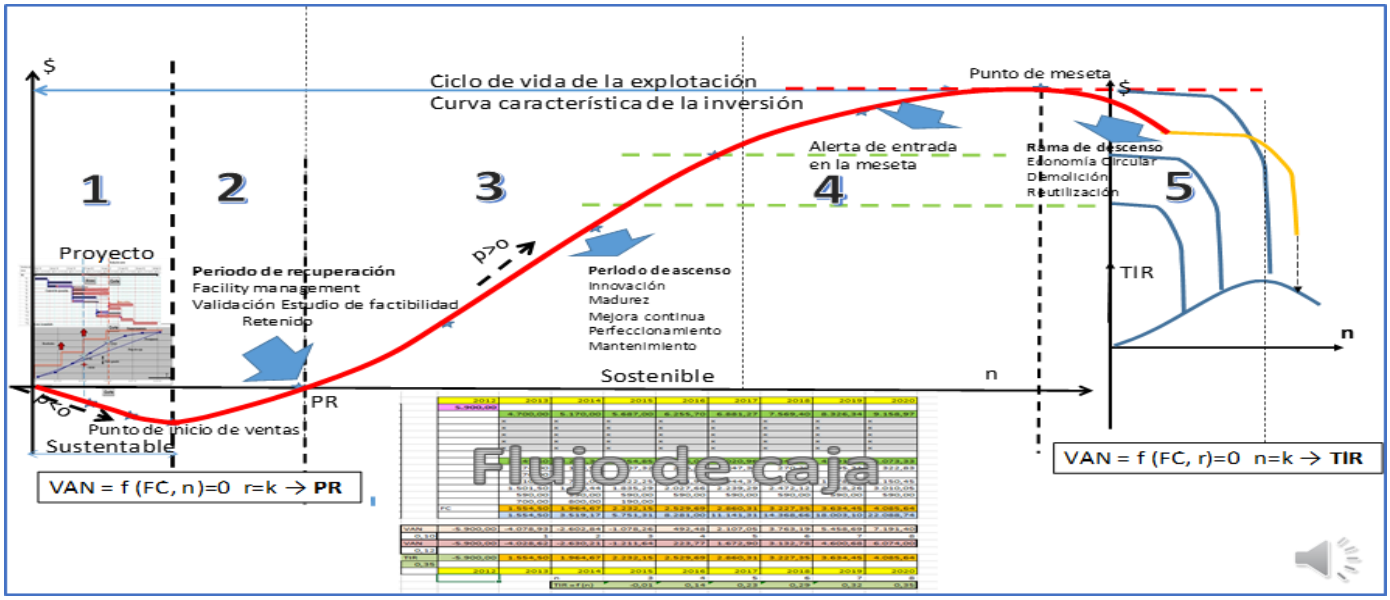


Figure No 4. Characteristic curve of the exploitation process

The information and communication system, in the integrated management system, with the alert of the plateau area, where the process of reuse of resources and the circular economy begins, at the closing of the investment, represented by five main stages : stage 1, until project closure with the value of –Ao value of the investment, stage 2 of the payback period, stage 3 of ascent to the plateau and stage 4 on the plateau and stage 5 as the closure of the exploitation, as shown in the characteristic curve of the exploitation process in figure No 4 ..

Stage 1. Closing of the investment project

In the closing process, compliance with the provisions of the directive documentation of the basic engineering process is validated, it is where the objectives, the results, the client's requirements, the preliminary project, the risks, the feasibility study, the permits are foreseen. , the licenses, the budget, the financing of the investment and the contract, in order to provide the necessary information to proceed with the development of the detailed engineering and construction, where the necessary information is generated, to proceed to the closing of the project of investment, attending to the fulfillment of the contracts and the deviations identified in the execution process in relation to the baseline of the investment associated with the behavior of the cost indicators, time, quality, the performance of the workforce and logistics, all of which is collected in the investment file, which is updated and closed following the

indications of the good as practices. This process is apparently simpler than but as important as the previous ones, due to the cost increases that it generates without productive support.

Stage 2. The ascent branch until the recovery period

The start of the promotion branch is characterized by the putting into operation of the facility, with the fine-tuning of all the specialized systems and the preparation of the human resources that participate in it. The diversity of problems that arise in this stage requires an efficient integrated management system that responds to the problems of commissioning.

The management of operations at this stage are planned in the feasibility study for the period. It is necessary to adjust the tasks with resources, durations, dependencies and costs, according to current environmental conditions, in an inclusive schedule of all actions and where the budget arises from the planned inputs, respecting the cash flow, as a means to guarantee the NPV planned in the feasibility study, making use of the integrated management system.

The detainee, who with the use of BIM and the increase in quality guarantee a tendency to decrease, assumes the problems resulting from the construction design, not foreseen in the 6D preparation.

In the process of monitoring and control of the commissioning, various problems arise in the construction and assembly process, which must be resolved according to the provisions of the contract, between the project manager and the investor, with legal support. Corresponding, with the purpose of evaluating the causes and determining from where to take the economic resources, of the withheld or of the exploitation process. Sometimes an adjudicator is necessary to evaluate the causes and determine the economic sources to use.

Commissioning is the process that is structured in parts and integrated into the system, which may overlap in some cases with the closing process, in everything related to equipment and assembled systems that respond to contracted services. The set-up of the systems is another important aspect that must be planned and executed according to what is foreseen in the management system. Staff preparation and planned advice should be done as planned.

The use of the withholding is determined after an evaluation between the project manager and the investor with the necessary legal support, according to the contract. The unused withholding is returned to the project manager. The withholding is controlled during the guarantee period or investment recovery period, depending on the type of project and the provisions of the contract. Contributes to raising the quality of the investment. It represents a way to protect the cash flow of the investment, the rise of the NPV and the evaluation of the efficiency of the investment.

The Warranty Period, maintenance and upkeep are foreseen in the planning, with the costs in the vicinity of the entrance, maintaining the anticipated cash flow. All processes, systems and equipment have a guarantee period, which is offered by the manufacturer or executor and which has their greatest attention during the commissioning process according to the elaborated schedule.

Stage 3. The period of ascent to the plateau

From the recovery period, the second part of the ascending branch continues, in which the cash flows remain with a positive and growing trend, with an efficient work of the management of operations, Facility management and maintenance, in the framework of the cash flow contribution to maintain its trend. Creativity, innovation and continuous improvement are stimulated in search of improvement, maturity of the organization, relevance and development of human resource management. During this process, the gradient is positive until reaching the plateau.

Cash flow in this phase is characterized by an upward trend, given the improvement and use of means in good operating conditions. The production process itself in its development, induces the execution processes, with a deterioration of the means and a normal increase in maintenance costs, which generate reductions in cash flow, up to values that move within ± 5% depending on the type of investment and that generate the plateau.

The maturity of the organization and business intelligence, allow within the management system, to make good use of the cash flow support, with the purpose of continuing to increase the NPV and measure the efficiency of the investment, based on the expected contribution of financial economic management to the investment program.

During the interval, great attention is paid to the variation of the cash flow values close to the plateau, where an analysis is required for decision-making, within the framework of the management system.

Stage 4. Evaluation of the plateau

The management system must have foreseen an analysis of the variations of the cash flow in the promotion branch as a warning of it, since in the plateau the cash flow values remain very close to a balance value, in the that income and expenses are similar and therefore there are no notable increases in cash flow, which make NPV constant. The interpretation of the plateau, with constant NPV values, without notable increases in cash flow, leads to an analysis of the end of the investment. It is the moment when decision-making becomes evident. Staying on the plateau without increases in cash flow, where sales inflows are equal to outflows to guarantee sales, which do not bring benefits to the

facility and a deterioration of the facility, with a tendency to prohibitive increases in costs in maintenance, make the management system act effectively in terms of decision-making, due to the non-continuity of the investment.

Investment closure

The closure is characterized by reflecting the values of the fixed assets that will be subject to reuse, demolition, relocation and transformation, using the techniques provided with the materials used. The circular economy planned from the beginning in basic engineering and detailed engineering, with the design of the materials to be used and the means used in reuse. The file gathers all the details of the investment from costs, time, quality, logistics and the behavior of human resources, with the inventories of the recovered resources.

The delivery certificate is prepared, which reflects the commitments established in the contract and the degree of satisfaction of the client and the interested parties. Good practices are collected and reflected in the BIM information system, which integrates the information from beginning to end, with version control of the contract and its supplements.

In the closing process, the indicators are updated according to the costs and real times, with the fulfillment of the quality indicators. In the exploitation process, the result of the validation of the feasibility study is prepared, according to the performance of the investment, its impact and the evaluation of the client and the interested parties, both internal and external, for or against the investment.

Stage 5

It is the process after the closing of the investment in which the reuse of useful resources is developed in other investments, maintenance, development processes and dependencies of the organization that carry out other actions. The variation of the rising IRR is shown until values close to the plateau from which its decline process begins, indicating the opportune moment in which the investment operator and the organization's management system plan to close. and use of the benefits, in the strategy of execution of the investments of the organization

The sustainability of the organization

The organization's management system achieves its sustainability over time, as it develops a pool of resources shared between projects and investments in execution, with a portfolio of new investments oriented by a priority strategy, based on a matrix of variables that provide their sequence of execution, depending on the availability of financing and the social, economic and financial needs of the environment in which the organization develops, with efficient

management of operations and important advice from the group of experts, where the use of available financing is guaranteed, in investments based on priorities.

The sustainability process of the organization based on the control and monitoring of investments, is achieved to the extent that the appropriate decisions are made during the upward branch close to the plateau of the investment characteristic curve, where the Facility tasks Management and maintenance problems become more acute over time, with prohibitive values in costs, technologies begin to lose efficiency and staff are motivated by the use of new technologies, with better performance, less effort and cost reductions.

The sustainability of the organization that works with several investment projects to ensure their effectiveness, with an execution strategy based on priorities, based on several investments in operation and where it is important to make comprehensive decisions, there are usually two possibilities important:

1. Develop new investments during the development of the exploitation of the investment, making use of the cash flow values, generated in the current investment, decreasing the values of the NPV and the IRR, in the ascending curve of stage 3, in search of new developments and improvements, with the extension in cost and time of the exploitation characteristic curve, the possibilities of introducing new risks, with the participation of the interested parties in the adjustment of the current investment design.

2. Maintain the investment from beginning to end according to the characteristic curve of the exploitation of the investment, with the cash flow and the expected increases in the NPV and the IRR, accumulating the values until the beginning of the plateau and taking the benefits of the management economic and financial obtained, in the development of the new investments, planned in the order of priorities of the investment program, that allow the continuous development of the organization.

The management system must provide all the elements for making the most appropriate decisions to the environmental conditions of the organization, although taking the investment from start to finish, collecting the expected benefits and giving way to the design of the new investments planned in The program execution strategy, depending on the priorities, is a variant aimed at guaranteeing the stability and sustainability of the organization, avoiding improvisations and creating an important financing fund to guarantee the investment program based on its priorities.

The investor must be well prepared and informed, to assume the management of the process, with decision-making in the changes that occur during the exploitation of the investment, in order to guarantee the sustainability of the organization.

Conclusions

1. The development of the topic shows the importance of the effective management of the exploitation in the investment process, with the purpose of guaranteeing the results foreseen in the feasibility study of the basic engineering.

2. The sustainability of the organization is achieved, to the extent that it has an investment execution strategy, based on a planning based on the priorities of the variables and indicators of the investments in a matrix, which allow with the advice of the experts, define a sequence of execution of the investments, avoiding improvisations, in a process of orderly management of the investment process.

3. The characteristic curve of the exploitation process, based on the feasibility study, provides the investor with a useful management tool to guarantee the stability of the cash flow in the rising current of the NPV and the IRR up to the plateau, with the purpose of guarantee the economic and financial benefits that allow the sustainability of the organization.

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